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MEMORANDUM REPORT NO. 1860

THE EXPLOSIVES MODELING FACILITY AT THE BALLISTIC RESEARCH LABORATORIES

by

James E. Cole

July 1967

U. S. ARMY MATERIEL COMMAND
BALLISTIC RESEARCH LABORATORIES
ABERDEEN PROVING GROUND, MARYLAND

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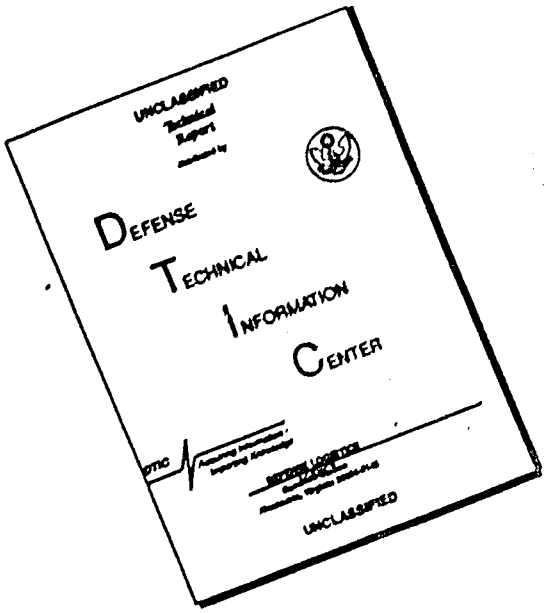

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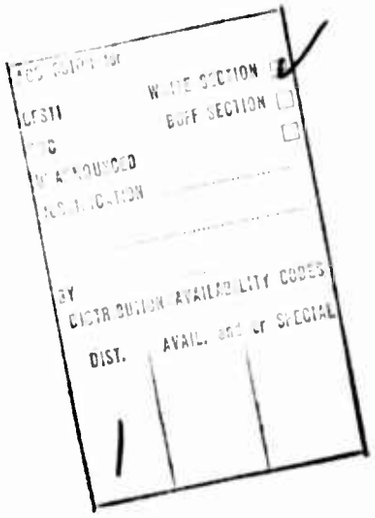

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James E. Cole

Interior Ballistics Laboratory

RDT&E Project No. 1P014501A33E

A B E R D E E N P R O V I N G G R O U N D, M A R Y L A N D

B A L L I S T I C R E S E A R C H L A B O R A T O R I E S

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ABSTRACT

This report describes the Explosive Modeling Facility of the Ballistic Research Laboratories (BRL). Some of the operations of the facility are discussed. Charges are made by cast loading, press loading, or machining high explosives. Strict quality control and safety practices are observed. The normal annual production is from five to seven thousand charges.

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I. INTRODUCTION

The Explosives Modeling Facility at the Ballistic Research Laboratories (BRL) has traditionally served to support research in terminal Ballistics. However, since 1963 additional research has been initiated by, or assigned to, this facility. The groups utilizing this facility are engaged in research in terminal ballistics, high explosives, or weapons system evaluation.

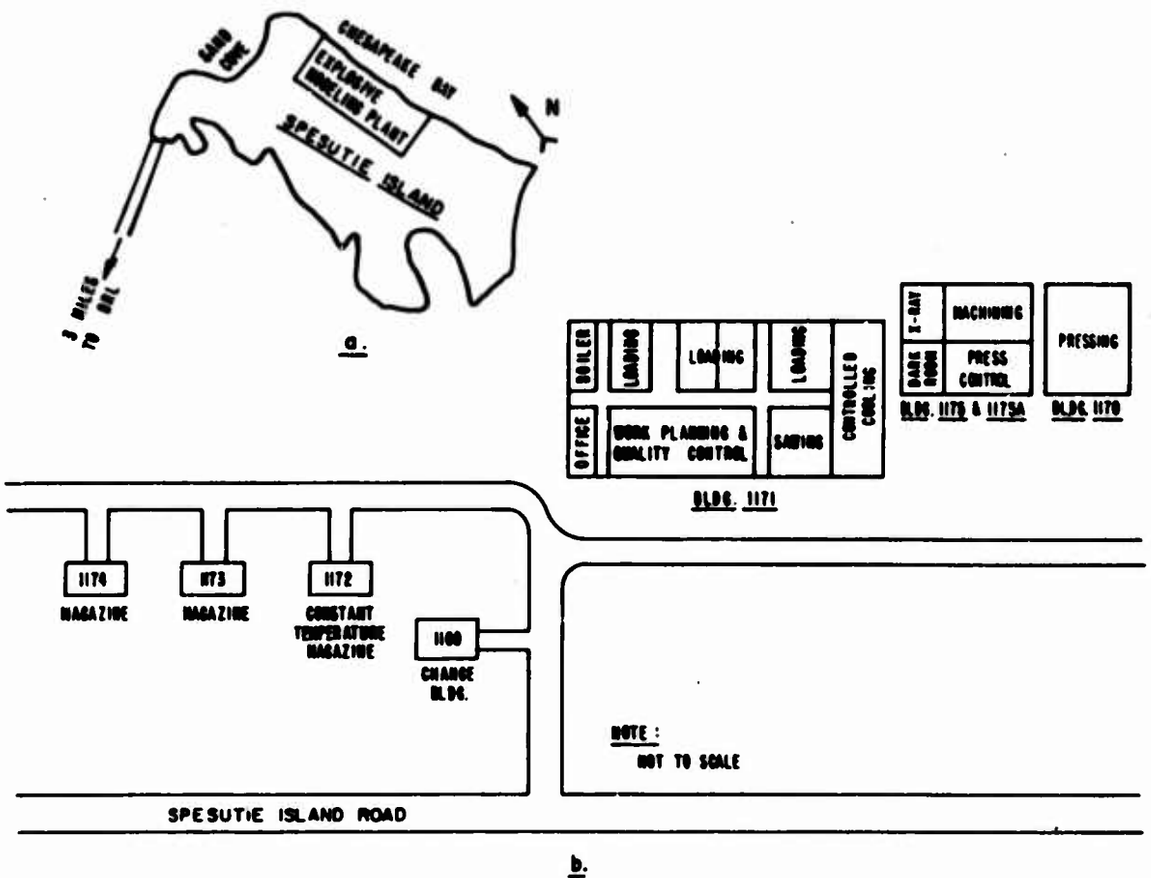

Figure 1. Location and layout of buildings at the Explosive Modeling Facility

The Explosives Modeling Facility (formerly Hot Melt Laboratory) is located in a remote area of Spesutie Island, 3 miles from the main BRL buildings on the Aberdeen Proving Ground (Figure 1a). The plant consists of a complex of eight buildings: a Press-Loading Building, a Cast-Loading Building, a Machining Building, an Analysis Building, a Change Building, and three-storage magazines (Figure 1b). The construction of each building complies with the Army Safety Regulations for explosives processing buildings (AMCR 385-224). The personnel who operate this facility have had many years of experience in processing explosives to support research.

It is the purpose of this report to describe the facility and some of the processing procedures for the benefit of those who need explosive charges to carry out research studies. There is nothing unique about the manufacturer's brand of equipment and so detailed descriptions of equipment are ommitted.

II. MANUFACTURING OPERATIONS

The manufacturing-type operations, such as cast loading, press loading, and machining of high explosives, are performed in separate buildings

A. Cast Loading - Building 1171

The Cast-Loading Building contains all of the facilities necessary for the preparation, inspection, and quality control of cast explosives. A cast explosive has trinitrotoluene (TNT, melting point 80.2°C) as a fusable binder for the explosive. The most familiar cast explosives used by the facility and by the Army are TNT. Composition B, Composition B-3, Composition B-4, Octol, Baratol, and Pentolite.

Figure 2. A typical loading room of the Cast-Loading Building

The Cast-Loading Building has separate rooms (Figure 1b), four of which are called loading rooms, a work-planning room, sawing room, and cooling room. The equipment in each loading room (Figure 2) consists of a large and a small kettle for melting chips of explosive, an oven to heat the molds, and a work table for cooling and finishing charges. Each loading room also contains three separate automatically controlled water

circulating systems for temperature control of kettles and molds (Figure 3), plus an exhaust system to remove toxic fumes arising from the explosive while it is in a molten state. Charges from as small as a fraction of an ounce to as large as 300 pounds can be prepared.

Figure 3a. View of control room for controlled cooling of molds

Figure 3b. Typical setup for controlled cooling of experimental molds

The equipment listed above and the processing procedure for loading are best understood by following a typical casting process (Figure 4) as performed in any of the four loading rooms as described below.

The explosives for melting are added as chips or crystals to the steam heated kettle (Figure 5). The ingredients are stirred from the time the TNT begins to melt until the molten mixture or melt is cast. Loading, or casting as it is sometimes called, takes place only after the melt has been thoroughly blended and has reached a prescribed casting temperature. Also during the blending time, the melt is degassed by

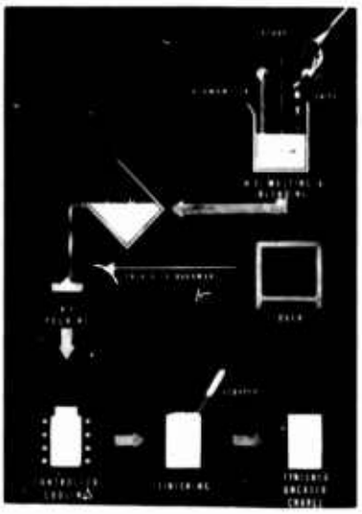

Figure 4. Melting, casting, and finishing of TNT explosives

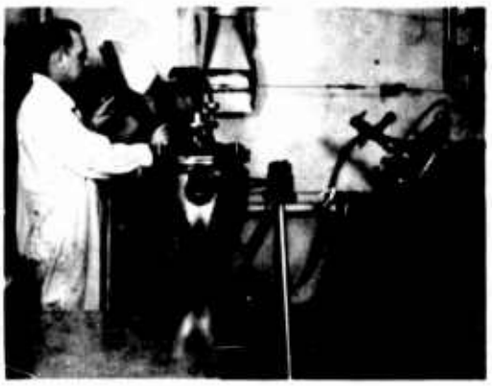

Figure 5. Chips of explosives are added to the kettle.

drawing a vacuum on the kettle. After the vacuum is released, the explosive is poured into heated molds (Figure 6) which have a top reservoir (riser) to allow for shrinkage of the explosive during cooling. The explosive-filled mold and riser assembly are allowed to cool slowly during which time the explosive solidifies. Finishing of the solidified charge consists of sawing off the excess explosive material (Figure 7) used to fill the riser and scraping the top surface until smooth.

Figure 6. Molten explosive is poured into the mold and riser assembly.

The work-planning room is used to weigh the bulk explosive before melting (Figure 8), to perform quality control on the finished charge (Figure 9) and to provide temporary storage for charges which are awaiting further processing. Quite often it is necessary to saw the explosive into small samples. Sawing takes place in the sawing room adjacent to the work-planning room. Because of its potential risk, sawing is remotely done, and the operation is viewed by television (see Figure 10).

After the charge is finished, it is inspected. Many of the charges require measurement as well as radiographic inspection to meet quality requirements. Inspection within the Cast-Loading Building includes gauging to see if the charge meets tolerances, determination of the density (Figure 11), and visual inspection for surface flaws.

B. Machining - Building 1175

Some pieces of explosive are prepared oversize in order to provide machining stock for smaller charges. This is always true for pressed explosives.

A 12-inch lathe with a contouring attachment or a milling machine is used for machining explosives (Figure 12). The operator makes his setup and leaves the machine rooom so that all operations involving tool and explosive contact, while the machine is turning, are remotely operated from outside the room and are observed by closed circuit television.

To obtain an acceptable level of quality for some types of charges, it is necessary to machine finish the outside surfaces to extremely close tolerances. At BRL, a tolerance of 0.002 inch in all measurements is considered adequate in view of the environmental changes a charge undergoes before it is used.

a.

b.

Figure 7. The riser explosive is removed and the top of the charge is scraped smooth.

Figure 8. Chip explosives are weighed in the work-planning room.

Figure 9. Charges are inspected and measured in the work-planning room.

Figure 10a. View of saw with charge ready for sawing

Figure 10b. Operators view on TV monitor

Figure 11. Triple-beam balance used for the determination of density

Figure 12a. View of lathe with charge ready for machining

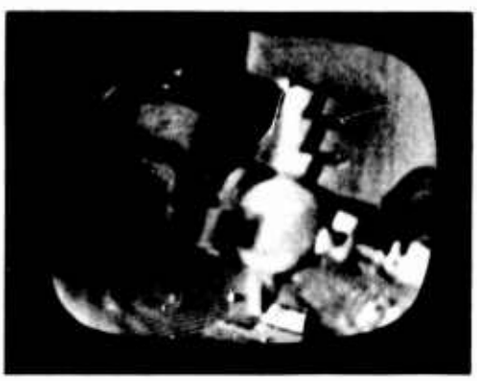

Figure 12b. Operators view of TV monitor

Figure 13a. Two-story Building 1170 used for pressing explosives

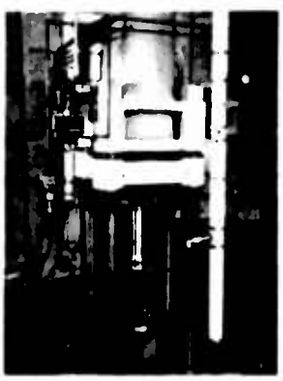

Figure 13b. Hydraulic press

Figure 14a. View showing top ram and chamber of press

Figure 14b. Operators view on TV monitor

C. Press Loading - Building 1170

The Press Building which houses the hydraulic press for consolidating powdered explosives is of two-story construction to allow for suspending the press vertically between the upper and lower rooms (Figure 13). The top ram of the press extends down from the upper room, and the bottom ram extends up from the lower room of the building. The chamber for containing the powdered explosive during compacting is set at the level of the top floor (Figure 14).

To press an explosive, these steps are followed: (1) The powdered explosive is heated in an oven located on the bottom floor, and the chamber is heated in place by circulating hot oil in a jacket surrounding it. (2) The chamber is loaded with the hot explosive by an operator after the bottom ram is positioned to seal off the bottom of the chamber. (3) All personnel leave the Press Building, and the remainder of the press operation is remotely controlled from a panel in Building 1175.

At the control panel, the duration of the compacting operation is set on a timer integral to the up and down motion of the press ram. To start a cycle, a button is activated to advance the top ram to seal the top of the chamber and then stop. Next the chamber is evacuated to a pressure of approximately 1 millimeter of mercury. When evacuation is

complete, the cycle-start button is again pushed and the advance of both top and bottom rams compacts the powder at a pressure selected at the control panel. The pressure is held constant for the duration of the cycle. At the end of the cycle, the top ram withdraws completely and the bottom ram pushes the charge out through the top of the chamber. The compacted charge is referred to as a billet. Since it is hot when it emerges from the press, it is insulated and set aside to cure in a constant temperature magazine. The cured billets are used as machining stock for preparing small charges. Billets 2, 4, and 6 inches in diameter by 8 inches in length can be compacted in the press.

III. SUPPORT OPERATIONS

The supporting operations of the facility include X-ray and film developement and analysis of high explosives Change rooms for operators and storage space for high explosives are also provided.

A. X-ray and Film Development - Building 1175A

Quality control using radiographs of the explosive charges is necessary to detect internal flaws. To accomplish this a 90-kilovolt or 250-kilovolt X-ray machine is used to radiograph the charges (Figure 15). Exposure of the film to X-ray is made in the front half of the building which is constructed for explosives operations. In the back half of the building the film is developed and examined (Figure 16); no flaws are permitted in experimental charges.

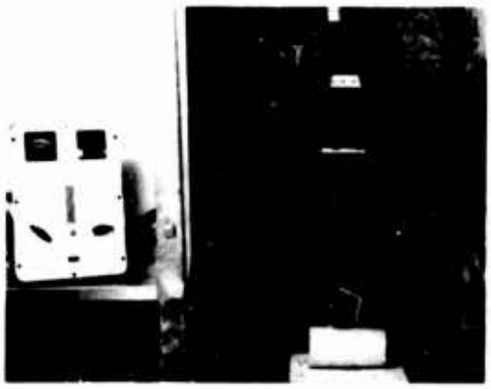

Figure 15. A 90-kilovolt X-ray machine used to radiograph charges

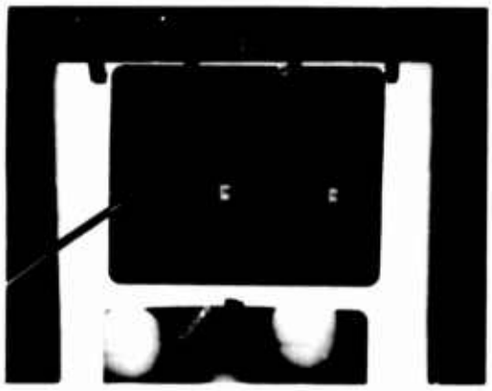

Figure 16. Radiographs are viewed and interpreted.

B. Analysis - Building 1123

From time to time it is necessary to determine the characteristics of bulk explosives and of the explosives after they have been made into charges. The building in which this is done is equipped so that an operator can determine the composition analysis, the drop-height sensitivity, heat of explosion, and density of an explosive. The interpretation of this type of data leads to methods of preparing and selecting high quality explosive charges.

C. Change - Building 1169

Uniforms are provided for protecting the operators and for reducing contamination from explosives. The Change Building provides an area to change from street clothes to work uniforms. It also provides an eating and rest area away from hazzards of the explosives.

D. Storage Magazines - Buildings 1172, 1173, and 1174

Magazines are available to store 2100 pounds of explosives. Two of the magazines are for bulk chip-size explosives, and a third magazine is used exclusively for completed charges. The third magazine, Building 1172, is kept at constant temperature to eliminate temperature cycling effects on the charges before testing. The third magazine also serves as a holding place for completed charges awaiting testing elsewhere on the BRL ranges.

IV. PRODUCTION

The facility has been able to keep pace with tasks which collectively have required five to seven thousand individual charges of numerous shapes and sizes annually. The emphasis has always been to produce high quality charges in the least practical time.

In the future fewer numbers of charges but of higher quality will be made. To meet these requirements, the present facilities are efficiently coordinated and projects plan reasonable lead time for manufacturing operations.

A change in need for charges prepared by sectioning large blocks of explosives instead of cast loading to near finished dimensions would cause a temporary unbalance of activity. However, the advantages of cutting large blocks to make smaller charges are presently the subject of research.

Press loading equipment is a relatively new addition to the activities of the facility. The utilization or expansion of pressing in the future will also depend on the outcome of studies now in progress.

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